Environment, Optimism and Productivity of Regional Innovation Systems

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ABSTRACT

This paper relates three features of the environment: the transportation infrastructure (strongly related to commuting), the climate (related to optimism), and the safe environment (related to willingness to exchange short term with long term) with research productivity. It uses a panel data methodology in data for the 48 regions of the five largest economies of the European Union (Germany, France, Spain, Italy, United Kingdom) for the period 1995-2007. The finding supports the hypotheses the features of the external environment that impact the psychology of the researchers increases the regional innovation system productivity mainly by increasing optimism and decreasing pessimism, and commuting costs.

Keywords: Regional Innovation System, EU regions, environment, optimism, creativity, knowledge production function,

JEL Classification: O31,O32, R11

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1. Introduction

Creativity (thinking of new ideas) and innovations (doing something for them) (Prior, 1996) have economic importance because new scientific findings and inventions create jobs. Even more, creativity and innovation help individuals, organizations and societies to adapt to continually changing needs to remain competitive (Sternberg and Lubart, 1996). Adaptability is essential to an organization's success in today's economic environment. Organizations must change at the speed of change and creativity and innovation is important to do so. On the other hand, optimism, produce positive emotions, increases the role of creativity. Both optimism and creativity are associated with academic performance (Sanchez, et al., 2010) and thus with research and innovation. Therefore, if we focus on the role of creativity on the R&D, the productivity of researchers, inventors, organizations and regional innovation systems depends on the creativity and optimism of the individual persons. If this is the case does the external environment, physical and humanly built, play a role on the psychological emotions of the researcher and inventor? The answer is yes, according to the investment theory (Sternberg and Lubart, 1996)

Because of the importance of innovation to economic growth, national and regional, literature has given emphasis on recognition of the factors affecting innovation productivity. Inputs in the knowledge production function, such as research and development expenditures and number of scientists, form one group of these factors (Grilliches, 1990; Teitel, 1994; Acs, et al., 2002 ; Furman, et al., 2002). The national innovation system theory emphasizes the role of institutions and organizations (Teitel, 1994; Grande and Peschke, 1999; Mauro, 1995; Yang and Maskus, 1999; Varsakelis, 2001; Varsakelis, 2006; Furman, et.al., 2002). However, the regional knowledge production function literature has not examined thoroughly the role of the environmental externalities, positive and negative.

Several studies have related psychology to employee performance. They have examined various factors affecting psychology, including the human built (Young and Berry, 1979; Lohr et al., 1996; Shikdar and Sawaqed, 2003; Clements-Croome, 2006) and physical surroundings (Moos, 1976; Sanders and Bizzolara, 1982) of the workplace. They have also shown that employees who bring negative emotions to work stay in a bad mood throughout the day resulting in productivity decrease.

Even though, previous studies have examined the role of psychology in the productivity of employees, no study as far as we know, has related optimism and positive emotions with research productivity. In this paper we examine the importance of some environmental factors that may affect the psychology of the researchers and eventually productivity of the regional innovation system. We examine three features of the environment: the transportation infrastructure (strongly related to commuting), the climate (related to optimism), and the safe environment (related to willingness to exchange short term with long term). We decide to follow this approach as a first step in dealing with this issue because no micro data are available to connect direct positive emotions with research productivity. Therefore, we use indirect indices assuming the conditions measured by these indices have an impact on the researchers' psychology and eventually on the productivity of the regional innovation system.

We apply panel data methodology in data for the 48 regions (NUTS I classification) of the five largest economies of the European Union (Germany, France, Spain, Italy, United Kingdom) for the period 1995-2007. The empirical results of the paper are summarized. The number of rainy days in a region affects negatively regional innovation productivity. The quality of the transportation infrastructure is positively correlated with the regional innovation productivity. The role of criminality on regional innovation productivity is negative but weak. Therefore, our finding supports the hypothesis the features of the external environment that impact the psychology of the researchers increases the regional innovation system productivity mainly by reducing optimism and increasing pessimism, and commuting costs.

This paper consists of four parts. The second states the research hypotheses. The third part describes the data, presents and discusses the empirical findings. Finally, the fourth part offers some concluding remarks.

2. Theoretical framework and hypotheses setting

The empirical literature has thoroughly discussed some of the determinants of innovation giving emphasis on the role of R&D expenditures. Pakes and Griliches (1980) using data at firm level in a knowledge production function found a statistically significant relationship between the number of firms' patents and R&D

expenditures. Hausman, et al. (1984), using a panel data set at firm level, found that firms are getting less patents from their most recent R&D investments, inferring a decline in the productivity of R&D. Jaffe (1986) in a firm level study, supported that patents are systematically related to the "technological position" of firms' research programs. Love and Roper (1999) inferred the technology transfer and the networking are important substitutes for the R&D expenditures in the innovation.

Environmental externalities enter Grilliches (1990) knowledge production function (KPF):

$$Y = F(X; E),$$

where Y stands for knowledge output; X the vector of knowledge production function inputs, such as R&D expenditures; E is a vector of environmental externalities. With the term "environment" or "environmental" is defined the social and institutional environment surrounding of an innovation system (firm, region, and nation) that influences the behavior and properties of the system (Damanpour and Gopalakrishnan, 1998).

Mohr (1969) introduced the environmental effects in the innovation. He considered the sectoral environment (market conditions, technological changes, clientele needs and demands, and labor market) and the social environment. Varsakelis (2001), using data at country level, found that national culture does matter as a determinant of the national innovative activity. Varsakelis (2006) found the development governmental institutions and the quality of education are primitively correlated with the productivity of the national innovation system.

Regional innovation system (RSI) is not clearly defined. However, the studies on the performance of regional or local systems of innovation (RSI) soared up since the 1990s, because of the recognized importance of the local supply of managerial and technical skills, the accumulated tacit knowledge, and the knowledge spillover (Chang and Chen, 2004). Doloreux (2003) defined RSI as "a set of interacting private and public interests, formal institutions and other organizations that work according to organizational and institutional arrangements and conducive to the generation, use and dissemination of knowledge". Cooke et al. (1997) used three characteristics for the RSI: the financial capacity, the institutional learning, and the productive culture.

Regional development occurs in places where localized capacities such as institutional endowment, built structures, knowledge and skills exist (Doloreux and Parto, 2004). Calderon and Serven (2004) found the stock of infrastructure assets affects positively economic growth. Bronzini and Piselli (2006) estimated the long-run relationship between total factor productivity, R&D, human capital and public infrastructure across the Italian regions between 1980 and 2001. They found the R&D activity and the public infrastructure of neighboring regions affect positively regional productivity. Satya (2003) examined the effects of public infrastructure on the cost and productivity in the private sector in Australia. Satya inferred that public infrastructure has a positive and significant impact on private firm's productivity. Ezcurra et al. (2004) concluded that public infrastructure in the regions of Spain noticeably reduces the private costs and increases the overall productivity. Finally, according to Rietveld and Nijkamp (1992), regional development is the result of the efficient combination of private labor and capital as well as of the public infrastructure such as transport.

Since external environment is valuable for the regional economic productivity it is also conducive to innovation. The human- made environment and specifically the transportation infrastructure provides the setting for human economic activity and innovation activity. According to Stohr (1986) four interrelated factors, namely: skilled labor force, diversified urban base, and efficient transport and communications networks affect regional productivity.

Mobility has become a key concern in cities throughout both the developed and developing world, as it greatly affects the livelihoods and lifestyles of many millions of urban dwellers. The 20th century was a period of rapid motorization, bringing with it enormous social and economic benefits. But the widespread use of vehicles also brings real environmental and economic costs. These costs have risen dramatically in the past few decades and vehicles now represent a major source of air pollution and global greenhouse gas emissions. Investment in urban transport and communications infrastructure is critical for balanced regional development and for raising economic potential in urbanized areas. A single mode of transport is rarely satisfactory for urban mobility.

Since residential and job locations do not coincide commuting is a need and thus a worker incurs commuting costs. These costs mainly include monetary, travel time, and psychological costs (e.g., risk of accident, discomfort), and the available evidence suggests that they are substantial. The estimates by Small et al. (2005) and Van

Ommeren and Fosgerau (2009) imply that if ten trips per week are assumed the weekly commuting costs are around $130. The theory of labor supply has stressed that commuting costs (or, more, fixed work costs) affect the opportunity price of leisure, leading to adjustments in the labor supply. Commuting costs also play an important role in urban economics theory, where the price of housing is generally determined by access to work (see, e.g., Alonso 1964, Muth 1969). Furthermore, as Oi (1976) recognized, the urban variation in housing prices opens the possibility the worker's residential location influences the demand for leisure, if leisure and housing are related in consumption. Therefore, better transportation improves the RIS productivity because due to lower commuting costs, researchers spend less time on the roads and more for researching and relaxing. Besides, the big commuting times impose extra tension to the commuter reducing that way the clear thinking and the mental "productivity".

Finally, an efficient transport makes easy the tacit knowledge spillovers since the ease of transport makes personal contacts easier. Based on the above discussion we posit the following hypothesis:

Hypothesis 1. The better the transport infrastructure the higher the innovation productivity.

Creativity is the ability to produce work that is both newer (original or unexpected) and appropriate or meet task constraints (Sternberg and Lubart, 1996). Creativity is a process. A process of generating new ideas (Gurteen, 1998) requiring to "get out of the box" to find ideas, problems and solutions that are normally not present (Sanchez, et al., 2010). The importance of creativity as a driving force in regional economic growth and prosperity has been documented by Florida (2002). However, creativity is not sufficient for economic improvement. Innovation is needed. Therefore, creativity is significant for regional innovation.

Now, if we focus on technological innovation, on creative regions the willingness to take risks, the curious sense of humor and the attempt difficult tasks characterizes researchers and inventors. According to investment theory, creativity needs intellectual abilities, knowledge, styles of thinking, personality, motivation and environment (Stenberg and Lubart, 1996). But even if a person has the intellectual abilities and the knowledge to be creative, a risk averse personality and the unwillingness to tackle with difficult tasks, make the person not creative. Optimism is the ability to see, consider and aim for realities not happening at the present (Sanchez, et al.,2010 and Reffel, 2010) The optimistic person expects that things will improve contributing to this alternative positive reality by building it progressively with their actions , thoughts and feelings in the present. Optimism is related to the ability to delay gratification and to renounce short term benefits in exchange for more valuable long niter objectives, probably because the person considers these objectives to be reachable.

On the other hand the pessimistic person believes that bad events will last a long time and they will undermine everything they do at present and future. Thus, optimism or pessimism may significantly affect the curiosity and motivation of a researcher or inventor. The external environments determine the psychology of the researcher by creating optimistic or pessimistic emotions. Even more, the negative external social environment may affect the attitudes by making them risk averse.

The regional climate has significant effects on human productivity. Young and Berry (1979) found the environment (lighting, noise, pleasant sounds, landscape, etc.) plays an important role in the expressed productivity of office workers engaged in decision-making, design, and/ or creative works. Lohr, et al., (1996) have shown that when working in a windowless work place, adding plants increases the worker's productivity. Shikdar and Sawaqed (2003) and Clements-Croome (2006) also argued the physical environment plays an important role in productivity. The surrounding environment affects not only the blue and white collar employees but also the researchers because the mood and psychology affect their creativity. We assume the better the natural environment the higher the regional innovation productivity. Therefore, a cleaner, less polluted, greener and shiny environment has a positive impact on the researcher's mood and psychology and thus leading to research and production of innovative ideas.

Based on the above discussion we posit the following hypothesis:

Hypothesis 2. The better the regional climate conditions the higher the innovation productivity.

In an unsafe environment, bad events usually last for a long time and people (and researchers) become pessimistic. Researchers as creative people consider realities that are not happening in the present. Pessimism, however, makes them believe that things could not be improved. Therefore, they are not willing to contribute to change things by building a new positive reality with their actions, thoughts and feelings. Besides, the exploitation of a monopoly rent from the property right of research motivates the innovator. However, an unsafe external environment does not protect property rights. Thus, the researchers do not exchange short term benefits, time and money, for long term objectives, as the innovation output because these objectives are not reachable.

Stohr (1986) used the term “agreeable” environment to portray the natural and the human built environments as well as the cultural, the educational and the other urban amenities. Institutions are the humanly devised constraints, or set of relational contracts that guide societal activities. They are made up of formal constraints (e.g. rules, laws, and constitutions), informal constraints (e.g. norms of behavior, conventions, and codes of conduct) and enforcement. Institutions provide the incentives that provoke or prohibit certain actions (Manning et al., 2000). Rules and regulations, formal and informal, define the incentives for the members of a society. This institutional environment shapes the expectations of society members.

Literature provides theoretical and empirical evidence that societies with institutions that protect property rights are more conducive for entrepreneurial actions and pro-developmental. Safety, that is protecting the property right for life, and productivity are compatible (Hinze and Parker, 1978). According to Taylor and Repetti (1997), social environments that threaten safety and undermine the social ties, by being conflictual, abusive, or violent, produce, in the long-run, health disorders such as chronic stress and mental distress. Mauro (1995) found a significant negative correlation between “subjective corruption indices" and growth rate. Gaviria (2002) found that crime and corruption substantially reduce firms’ competitiveness and that corruption is unlikely to have any positive effects. Peri (2004) found the annual per capita income growth is negatively correlated with the number of murders, after controlling for other explanatory variables. Dutta and Husain, (2009) argued that crime has serious importance on the state’s ability to promote development. In fact, an increase in government expenditure on security crowds out some key investments in infrastructure. Detotto and Otranto (2010) argued that criminal activity acts like a tax on the entire economy because discourages domestic and foreign direct investments, reduces firms' competitiveness, and reallocates resources by creating uncertainty and inefficiency. Crime discourages entrepreneurial behavior, hinders opportunities for employment and education and has negative consequences for social and psychological aspects of life and hinders the accumulation of assets (Lombardo and Falcone, 2011). Neanidis and Papadopoulou (2012) argued that crime influences economic growth through: a) a direct rise in the cost of doing business, b) a decline in competitiveness, c) a discouragement of foreign investment, d) a diversion of (private and public) funds toward crime prevention, and e) a limited investment in human capital accumulation. Empirical evidence has shown that crime depresses investments (Pellegrini and Gerlagh, 2004), growth and tourism (Peri, 2004), Cardenas and Rozo (2008), Gaibulloev and Sandler (2008), and increases inflation (Al-Marhub, 2000). Moreover, crime damages the country's image abroad since investors see it as a sign of instability and apparent chaos (Daniele and Marani, 2011). Cardenas and Rozo (2008) proved that lack of security is a major obstacle to growth in Colombia. After all it is common knowledge that countries/ regions with high crime rates such as South Africa, Jamaica and Haiti are not profitable for investments (Crime and Small Businesses SBP report, 2008).

Adapting to our analysis, unsafe social environments affect negatively researchers' productivity.

Based on the above discussion we posit the following hypothesis:

Hypothesis 3. The safer the environment the higher the regional innovation productivity.

3. Empirical Estimations and Discussion

Based on the previous discussion, we estimate a regional knowledge production function (KPF) as proposed by Griliches (1990):

(1)

where *Y* is the knowledge output, *R&D* is the expenditure for research and development, *RESEARCHERS* is the number of researchers, and **E** is a vector of environmental externalities. We approximate (1) by a Cobb-Douglas production function with constant returns to scale:

(2)

We assume that **E** enters exponentially into the production function. The constant *A* could be regarded as the technology used in the knowledge production function or the total factor productivity. Now, dividing through by *RESEARCHERS,* we obtain:

(3)

Or more simply

(3a)

Where *y* is the per researcher knowledge output, and *rd* is the per researcher R&D expenditure. So (3a) is the per researcher productivity of the regional innovation system.

Taking the logarithms of the (3a) we get:

(3b)

where α is the elasticity of knowledge output with respect to R&D expenditure and **b** is the vector of coefficients of the environmental variables. Incorporating the hypotheses of the previous section into equation (3b) we obtain the regional knowledge production function extended with externalities:

where is the regional index and *t* is the year.

The net accretion of economic valuable knowledge is an unobservable variable. Thus, the proxy measures used by research have always been incomplete and reflect only some aspects of the technological change (Grilliches, 1990 and Acs, et al. 2002). Since, however, the inventor makes an application for a patent, considering the cost, we may assume he has also considered that the economic value of the patent exceeds a minimal threshold limit (Grilliches, 1990). Moreover, because patents and new knowledge production are related to a crude reduced-form-type, patents can be used with the limitations discussed in the literature (Grilliches, 1990; Acs and Audretsch, 1989; Furman, et al. 2002). Acs et al (2002) compared at regional level the literature-based innovation output measures (as they are published in trade and technical journals) and the "patent" as direct indicators of "innovation". They found that a "patent" is a reliable innovation output. For these reasons, the literature has used patents extensively as the output of knowledge production function. We use the logarithm of patent applications per researcher at regional level (denoted as LPCPA in our data set) as a proxy for the output of the knowledge production function. We use the patents by application date because it is the application date when new knowledge becomes public. Besides, the lags between application and license are long and random (Jaffe, 1986). According to Eurostat, the regional distribution of patent applications is assigned according to the inventor's region of residence. The applications with more than one inventor are divided equally among them and subsequently among their regions of residence, avoiding double counting [1].

The drawback of using the patent applications filed at the EPO is single intermediary role of EPO. Therefore, the cost of double patenting (national and European) may prevent some small firms from demanding to extend their patent protection at the European level. On the other hand, Maurseth and Verspagen (2002) argued that patents filed at the EPO are more likely to have higher average quality and Cefis and Orsenigo (2001) pointed out data from EPO are readily comparable because EPO uses a very homogeneous procedure.

The variable *rd* is measured by the logarithm of the total intramural R&D expenditure per researcher at regional level (denoted as LPCRD in our data set). The sign of *a* is expected to be positive. We apply a variety of proxies for each the three dimensions.

The paper uses two indices for the quality of road infrastructure: the crude death rate per 100.000 inhabitants caused by transport accidents (denoted as DTA in our dataset) and the number of people killed in road accidents (denoted as KRA in our dataset). The expected signs are negative since high numbers in both proxies signal poor quality of road infrastructure. Another characteristic of the transport infrastructure environment is the size and quality of regional airports. We use the logarithm of air

[1] Patent applications to the EPO at the regional level. Eurostat Metadata in SDDS format: Summary Methodology http//.epp.eurostat.ec.europa.eu/.

passengers embarked and disembarked in the region's airports (denoted as LAP in our dataset) in the NUTS I regions. We expect that the number of air passengers is positively correlated with the productivity of the regional innovation system. Finally, we use the logarithm of kilometers of motorways (denoted as LMW in our dataset) as an indicator of the accessibility degree in a region. This variable is positively related to the regional innovation productivity.

The number of rainy days per year (denoted as LDR in our dataset) is an indicator for the climate. Following the discussion of the second section, we expect the sign to be negative, i.e. more rainy days have a negative impact on optimism and so on creativity and innovation.

We use two variables for safety; the crude death rate per 100.000 inhabitants caused by assault at regional level (denoted as DAS in our dataset) and the number of car thefts in core cities per 1000 inhabitants (denoted as CT in our dataset). The data for these indices are published by Eurostat every four years. We assume that these variables are stable in the interval between the four years. Since persistence of crime creates pessimism about the future positive realities and afterwards on creativity and innovation, we expect that both variables have negative sign.

Data and Methodology

Data are from the Eurostat. The empirical estimations focus on the regional innovation systems of the five largest countries of the European Union, namely: France, Germany, Italy, Spain, and United Kingdom. Therefore, data for the 48 regions (NUTS I classification) for the period 1995-2007 were used in the regressions.

Because of the panel structure of our data set, we examined the pooled OLS method, the random effect and the fixed effect method. For space economy we only report the fixed effects results as suggested by the Breusch-Pagan and Hausman tests.

Table 1 presents the descriptive statistics. The mean of the variables representing the transport infrastructure is 22,5 for DTA; 95,5 for KRA; 13848 for AP; 862,31 for MW. The mean of the variables representing the safe environment is 4,9 for CT and 0,9 for DAS. The mean of rainy days (DR) representing the climate is 158,11. The mean of the R&D expenditures per researcher (PCRD) is 0,08 while for patents per researcher (PCPA) is 0,02. The minimum value of patent applications per researcher is 0,001 and corresponds to the region Canarias of Spain for the year 1997. The maximum value is 0,08 patent applications per researcher and corresponds to the region Baden-Württemberg of Germany for the year 2006.

Table 2 provides the correlation matrix. The level of correlations indicates that the problems of multicollinearity is not an issue in the regression models.

Empirical results and discussion

Table 3 presents the results of the fixed effects regressions. Because some of the explanatory variables are proxies for the same variable we use interchangeably in the estimated equations. We report 23 modes of the estimated equation and as the $R^2 - adj$ suggests they fit the data well.

The estimated coefficient of the R&D per researcher is statistically significant with the correct positive sign. This empirical finding is consistent with the existing literature, which supports the positive effect of the R&D expenditures on the output of the regional knowledge production. The elasticity of the KPF output with respect to R&D expenditures ranges from 0.228 to 0.845. We conclude from this finding that the intensity ratio "R&D Expenditures / Researchers" ranges from less than unity to greater than unity. Hence, there is not clear evidence on whether the average regional knowledge production function is R&D or researchers intensive.

As we said previously, the estimated constant of the knowledge production function is an estimation of the total factor productivity of the regional innovation system. The average total factor productivity across the 45 regions ranges from 0.003 to 0.24 in different estimated equations with an average 0.114.

Besides the expected strong correlation between R&D expenditures per researchers and patents per researcher, the empirical findings support our hypotheses. The alternative variables used to proxy for the transport infrastructure gave a statistically significant coefficient in most cases. The DTA and KRA have the expected negative sign and the LAP and LMW have the expected positive sign. Therefore, the quality of the transport infrastructure is positively correlated with the productivity of the Regional Innovation System. It appears the transport infrastructure underpins the Regional Innovation System productivity as the regional production system (Canning and Marianne, 1993; Canning and Pedroni, 1999; 2004).

Our results also support the second hypothesis. The coefficient of LDR (number of rainy days) remains strongly statistically significant in all equations. The negative sign provides evidence that the unpleasant climate in a region has a negative impact on the productivity of a regional innovation system. The *Silicon Valley* in the US and the *Sophia Antipolis* in France are good examples of the role of climate on innovation. These regions are inherited with an exceptional climate. The location of the *Sophia Antipolis* was selected exactly for its climate and the environmental quality. Our finding agrees with psychology studies that have found that the behavior and the working performance are highly related to weather conditions (e.g. Moos, 1976; Sanders and Bizzolara, 1982).

The role of safety on regional innovation system productivity is statistically weak. The estimated coefficients of the variables used –the number of car thefts (CT) and the death rate caused by assault (DAS) – are not statistically significant in all models. The sign, when they are significant, is, as expected, negative. This result may be due to the fact the data are not fully representative because car thefts are, sometimes, underreported (Forni and Paba, 2000). The low time variability maybe explains these findings. However, even though our empirical findings provide at least weak evidence, they support other studies that relate criminality to productivity. Forni and Paba (2000) showed that crime has a negative impact on economic activity and Entorf and Spengler (2000), using national and regional data, confirmed the negative impact of crime on economic performance.

4. Conclusion

The objective of this paper was to examine the impact of environmental factors on the regional innovation system's productivity. Environmental factors, natural, humanly built and institutions, have been examined for their impacts on sectoral, regional and national productivity. But it is the first time they are examined for their implications on the regional innovation productivity. The empirical analysis used data for 48 regions (NUTS I classification) of the five largest economies of Europe, namely: Germany, France, Italy, Spain, and United Kingdom, for the period 1995-2007.

The empirical findings are supportive of the three posited hypotheses. The number of rainy days in a region affects negatively regional innovation productivity. The quality of the transport infrastructure is positively correlated with regional innovation productivity. Finally, our findings provide weak evidence about the negative role of criminality on regional innovation productivity.

Our empirical results are interesting for the regional innovation policy. Firstly, high quality transport networks is a necessary condition for regions to be attractive to the research community. Our analysis at a regional level suggests the European Union and the regional communities should optimize the allocation of public resources in the quality and expand the regional transport infrastructure.

Conflictual, abusive and violent environments affect the productivity of researchers in two ways: by producing mental distress and second by reducing the incentives to research because of the limited protection of rights and life produce mental distress reducing that way the researchers' productivity. Even more, protecting property rights and life is strongly related to productivity. Our findings suggest that a safe environment is a significant positive externality in the regional knowledge production function and thus its sustentation could have a positive effect on regional innovation productivity, economic productivity and growth. Therefore, local and regional authorities should take measures to improve safety to attract research activities even though an increase in government expenditure on security may crowd out other investments in infrastructure.

Finally, when thinking the effect of climate on regional innovation productivity we are driven to the assumption that the Southern European regions have not exploited their advantage of the climate. Nowadays, where the southern countries such as Greece, Italy and Spain are facing the consequences of the economic crisis should follow the *Sophia Antipolis* example in southern France. The Southern European countries are inherited with geographic locations and sunny weather that could be treated as a strong advantage for attracting innovation.

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Table 1: Descriptive statistics

	Mean	**Median**	**Minimum**	**Maximum**	**Std. Dev.**
PCPA	0.022138	0.017672	0.0011125	0.087916	0.015859
PCRD	0.084053	0.085466	0.027417	0.16536	0.024503
DTA	22.565	16,45	1,60	94,70	18,19
DAS	0.93600	0,75	0,10	6,80	0,72
KRA	95.655	85,00	11,00	303,00	46,49
CT	4.9438	4,10	0,20	20,10	3,88
AP	13848.	6742.0	0,00	85965	17037
DR	158.11	173.00	59.000	250.00	49.491
MW	862.31	630.50	48.000	3877.0	730.12

Table 2: Correlation Matrix

	PCPA	**PCRD**	**DTA**	**DAS**	**KRA**	**CT**	**AP**	**DR**
PCPA	1,00							
PCRD	0,62	1,00						
DTA	-0,25	-0,35	1,00					
DAS	-0,24	-0,22	0,07	1,00				
KRA	-0,12	-032	0,59	0,10	1,00			
CT	-0,36	-0,19	0,14	0,11	0,14	1,00		
AP	0,02	0,19	-0.14	-0,09	-0,24	-0,03	1,00	
DR	0,20	0,36	-0,59	-0,09	-0,38	-0,005	-0,24	1,00
MW	-0,22	-0,004	0,46	-0,08	0,44	-0,19	0,10	-0,50

Table 3: Fixed Effects Models

	1	2	3	4	5	6	7	8
const	-2,015*** (0,317)	-2,134*** (0,303)	-2,165*** (0,293)	-2,533*** (0,260)	-1,971*** (0,345)	-2,688*** (0,345)	-1,786*** (0,466)	-5,906*** (1,048)
LPCRD	0,806*** (0,126)	0,742*** (0,121)	0,746*** (0,117)	0,5*** (0,116)	0,817*** (0,140)	0,644*** (0,110)	0,621*** (0,114)	0,590*** (0,116)
DTA		-0,004* (0,002						
KRA				-0,003*** (0,0009)				
LAP						0,023 (0,016)		
LMW								0,522*** (0,140)
DAS			-0,054** (0,022)					
CT					-0,022*** (0,008)			
LDR							-0,145** (0,069)	
R^2-adj	0,94	0,95	0,95	0,95	0,96	0,95	0,96	0,95
Obs	545	608	607	601	471	590	389	624
Hausman-test (χ^2)	20,2 (p-value=0)	29,06 (p-value=0)	34,86 (p-value=0)	39,73 (p-value=0)	22,77 (p-value=0)	39,85 (p-value=0)	34,64 (p-value=0)	52,31 (p-value=0)

Standard errors in parentheses are heteroscedasticity consistent. *** Significant at the 0.01 level; ** significant at the 0.05 level; * significant at the 0.10 level

LPCRD is the logarithm of the total intramural R&D expenditure per researcher at regional level. DTA is the crude death rate per 100.000 inhabitants caused by transport accidents, KRA is the number of people killed in road accidents. LAP is the logarithm of air passengers embarked and disembarked in the region's airports, LMW is the logarithm of kilometers of motorways, LDR is the number of rainy days per year, DAS is the crude death rate per 100.000 inhabitants caused by assault at regional level, CT is the number of car thefts in core cities per 1000 inhabitants.

Table 3: Fixed Effects Models (continued)

	9	10	11	12	13	14	15	16	17
const	-2.111*** (0.295)	-1.563*** (0.527)	-2.399*** (0.254)	-6.489*** (0.988)	-5.14*** (1.30)	-1.439*** (0.355)	-3.931*** (1.383)	-1.95*** (0.5)	-2.09*** (0.59)
LPCRD	0.691*** (0.118)	0.845*** (0.14)	0.509*** (0.115)	0.535*** (0.115)	0.649*** (0.2)	0.373*** (0.137)	0.407*** (0.135)	0.55*** (0.12)	0.44*** (0.12)
DTA	-0.005 (0.003)	-0.0035 (0.003)				-0.006** (0.002)			
KRA			-0.003*** (0.001)						
LAP								0.028* (0.016)	0.028* (0.015)
LMW				0.605*** (0.132)	0.484*** (0.128)		0.282** (0.133)		
DAS	-0.063** (0.028)		-0.045** (0.018)	-0.064** (0.025)				0.002 (0.02)	
CT		-0.02** (0.008)			-0.011 (0.007)	0.004 (0.008)	0.008 (0.008)		0.008 (0.008)
LDR						-0.321*** (0.08)	-0.19** (0.077)	-0.19*** (0.062)	-0.24*** (0.08)
R^2-adj	0.94	0.95	0.95	0.94	0.95	0.97	0.97	0.97	0.97
Obs	529	420	515	529	432	268	280	355	262
Hausman-test (χ^2)	30.16 (p-value=0)	13.19 (p-value=0)	44.01 (p-value=0)	62.70 (p-value=0)	28.49 (p-value=0)	35.55 (p-value=0)	52.15 (p-value=0)	50.90 (p-value=0)	34.88 (p-value=0)

Standard errors in parentheses are heteroscedasticity consistent.

*** Significant at the 0.01 level; ** significant at the 0.05 level; * significant at the 0.10 level

LPCRD is the logarithm of the total intramural R&D expenditure per researcher at regional level. DTA is the crude death rate per 100.000 inhabitants caused by transport accidents, KRA is the number of people killed in road accidents. LAP is the logarithm of air passengers embarked and disembarked in the region's airports, LMW is the logarithm of kilometers of motorways, LDR is the number of rainy days per year, DAS is the crude death rate per 100.000 inhabitants caused by assault at regional level, CT is the number of car thefts in core cities per 1000 inhabitants.